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2859

Organoleptic Identification of Roasted Beef, Veal, Lamb and Pork as Affected by Fat

SUMMARY—A taste panel was used to study the identification of roasted beef, pork, lamb and veal by flavor alone and the effect of fat on identification. Only about one-third of the panel could identify correctly all four meats by memory of the flavors. There was an increase in the total number of correct identifications made by comparison of the unknown roasted meat samples with known standards but this was not significantly greater than the total correct responses by memory of the flavor alone. Beef and lamb, but not pork and veal, were identified significantly less often when lean ground roasts were tested than when normal ground roasts (containing fat) were used. Texture, color, mouth feel, and other factors may be important in the identification of meat. Beef, lamb and pork fat, as well as these fats after extraction with chloroform:methanol, were added to lean veal prior to roasting. Addition of beef fat did not increase recognition of veal as beef. Pork fat contained a factor increasing identification of veal as pork, but this factor was water-soluble and could be removed. Lamb fat contained a component, or a fat-soluble component, that significantly increased the identification of veal as lamb.

INTRODUCTION

THE PROBLEM OF IDENTIFYING the chemical components of meat flavor could be simplified if it could be accepted that differences in meat flavors arise from the fat rather than the lean portion of the meat as has been reported (Hornstein *et al.*, 1960). However, such an assumption raises questions as to whether species flavor characteristics are really identifiable, and whether they could be attributed to the lean or fat portions of the meat.

Although many people believe they can identify cooked beef, pork, lamb or veal by flavor, preliminary organoleptic tests for the evaluation of meat flavor fractions indicated that the true differences between meats were not great. Without presenting data, Howe *et al.* (1937), commenting on the identification of meats by blindfolded people, indicated that beef and pork are identified correctly more often than lamb or veal. They attributed this to the presence of modified extractives and fat on the outside of the meat that has been exposed to high temperatures, and suggested that the distinguishable characteristics reside chiefly in a specific constituent of the fat.

Crocker (1948) prepared broths from meat and treated meats, and reported that neither the marrow, which is high in low-melting fats, nor the outside or tissue fats contribute greatly to beef flavor. Further studies by Kramlich *et al.* (1958) confirmed that the fat content of beef was not responsible for differences in flavors of broths prepared from meat. According to Hofstrand *et al.* (1960), lamb fat did not significantly affect the taste of broths made from lamb or mutton, but it may have contributed to the aroma of the broths.

The effect of fat on chicken flavor was reported by Peterson (1957) to be negligible. Extraction of lyophilized muscle with fat solvents did not reduce the flavor or odor of chicken broth prepared from the meat, and flavor profiles of the extracted meat were similar to, but weaker than, those of whole chicken broth. Pippen *et al.* (1954) also found that fat was of minor importance to chicken flavor, but did contribute something to the aroma.

The studies reported in this paper investigated the ability of the average consumer to identify meats commonly used and to determine some effects of the fat in characterizing the species of meat sources.

METHODS

THE MEATS USED in the study were eye roast of beef; veal shoulder roast; leg of lamb, rump end; and pork loin, loin end. These were purchased the day before the tests from a local commercial meat market. The meat was trimmed from the bone. When lean meat was desired, the meat was cut into small pieces, and all fat was removed including as much of the intermuscular fat as possible. Initial studies indicated that panel selections, using pieces of whole roast, were often based on color and texture rather than flavor. To reduce the influence of these extraneous factors the meat was passed twice through an electric grinder equipped with a plate with 3/16 in. holes.

When the effect of fat was to be evaluated, the meat was ground with 10% by weight of the selected fat to ensure homogeneous distribution. The ground meats were shaped into loaves and roasted at 350°F for 1½ hr to an internal temperature of approximately 190°. An initial test was conducted to compare the identification of hot roasts with that of cold roasts. The cold meat was identified with the same degree of accuracy as the warm meat; therefore, since it was more convenient to handle, all testing was carried out with meat roasted the afternoon before the test, refrigerated overnight and allowed to equilibrate to room temperature before serving.

The taste panel ranged from 27 to 31 people in the various experiments. A number of women were invited to participate on the panel to determine whether they were more discriminating than men in identifying the meats, based on their presumed familiarity with the flavor of the meats during preparation. Nonchemists, both men and women, were also included on the panel to establish the role of professional training in meat identification.

The panel was not a "trained" panel; it had not been screened to eliminate those with poor discrimination nor were the panelists specifically familiarized with the material to be tested. However, a number of the panelists had previously participated in organoleptic experiments with meat flavor and aroma. It was anticipated that a learning process might occur during the course of the testing but the panel responses to similar experiments near the beginning and end of the series were sufficiently alike to show this was not necessarily happening.

In the tests, the panelists were given four coded samples of meat in paper cups. The ground, roasted meat was broken into pieces to (1) reduce selection by color or texture, and (2) to mix the outer, brown crust with the inside meat for more uniform sampling. The panelists were asked to identify the meat samples, relying on their memory of the odor and taste of the meats. In one test the panelists were given four identified samples of meat and then requested to identify four unknown samples by direct comparison with the known meats.

The data were analyzed statistically by the Chi square test as described in Amerine *et al.* (1965). Analysis of variance could not be determined because the differences in sample sizes between the number of men and women and between the number of chemists and nonchemists were too great. Furthermore, the variance of the normal approximation is a function of sample size, so the variances of the groups would be quite different.

A number of the experimental results were confirmed with triangle tests where the panel selected the odd sample and identified both the odd and paired samples.

Beef, pork and lamb fats were extracted according to a modification of the method of Folch *et al.* (1957). Fifty-gram quantities of fat tissue were homogenized with 500 ml chloroform:methanol (2:1) for 1 min in a Waring blendor. The undissolved tissue and residue were removed by centrifugation. The chloroform:methanol solution was shaken with 100 ml of the upper phase of chloroform:methanol:water (8:4:3) mixture in a separatory funnel and the two phases allowed to separate. Water-soluble components in the upper phase were discarded. The chloroform:methanol solution was concentrated in a rotary evaporator under vacuum and the final traces of solvent removed by heating the fat to about 50°C on a water bath and bubbling N_2 through the liquid fat for 15 to 20 min.

Treatments

The meats were treated in the following manner. Experiments described in the paper refer to these treatments.

Experiment 1: Lean whole roasts. Whole roasts were trimmed of all visible covering fat, roasted and sliced for analysis.

Experiment 2: Lean ground roasts. Meat trimmed from the bones was cut into small pieces and all visible fat removed. After being ground twice, the meat was roasted.

Experiment 3: Natural ground roasts. Meat trimmed of a small amount of covering fat was ground twice and roasted.

Experiment 4: Direct comparison. Each meat was trimmed of fat, then fat was added back at the level of 10% of the weight of the meat. The meats were then ground twice and roasted. Labelled samples were presented to the panel. Unknown, coded samples from the same roasted loaves were given to the panel for identification by comparison with the labelled standards.

Experiment 5: Four veal samples. A veal shoulder roast, trimmed of fat, was ground twice and roasted. Each panel member received four coded samples of the roasted, ground veal in the same manner as in the previous experiments.

Experiment 6: Veal and beef, pork or lamb fat. Veal shoulder roast, trimmed of fat, was divided into four aliquots. Beef, pork or lamb fat, in 10% concentration by weight of the veal, was mixed with each of three aliquots of veal and ground twice before roasting. The fourth aliquot was prepared without added fat and served as a control for the identification of veal.

Experiment 7: Veal and extracted fat. The procedure was identical with that of Experiment 6 except that extracted fat was used. In all instances the term "fat" refers to fatty tissue rather than pure fats, except for the extracted fats.

RESULTS

THE RESULTS OF THE TESTS are shown in Tables 1 to 4. Table 1 is a compilation of the number and percentage of correct responses obtained in the various experiments. In Table 2 the experiments in each species of meat are arranged to show the relationship of significant differences among the response frequencies. There are no statistically significant differences among experiments that are underlined. The distribution of organoleptic responses to veal alone is presented in Table 3, and comparisons of the evaluations of veal to which the various fats have been added are shown in Table 4.

Effect of sex

No significant difference between the responses of men and women.

Table 1. Results of the experiments involving identification of four species of meat and the effect of fat on the rate of identification.

Expt No.[1]	Identification			Panelists					
	Total No.	No. correct	% correct	Total No.	% Identifying samples correctly				
					Beef	Lamb	Pork	Veal	All four
1	108	66	61.0	27	82.0	44.5	70.0	41.0	37
2	124	58	46.7	31	45.2	42.0	51.6	45.2	22.5
3	112	72	63.0	28	71.5	78.5	61.0	50.0	35.7
4	120	96	80.0	30	90.2	76.7	84.5	73.3	63.7
6	108	44	40.6	27	40.8	48.4	45.0	29.7	7.4
7	104	44	42.0	26	38.5	69.5	27.0	34.5	3.8

[1] For details of the experiments refer to methods.

Table 2. Relationship of statistical significance among the frequencies of correct responses as determined by Chi-square analysis.

	Experiment numbers[1]
Beef	4, 1, 3 — 2, 6, 7
Lamb	3, 4, 7 — 6, 1, 2
Pork	4, 1, 3 — 2, 6, 7
Veal	4, 1, 3 — 2, 6, 7

[1] Underlined experiments show no statistical differences among their responses.

Effect of training

There was no significant difference between the responses of chemists and non-chemists. (However, it should be noted that the number of non-chemists and of women on the panel were considerably less than the number of chemists and men.)

Effect of treatment

The only highly significant difference in responses of panelists was due to the treatments.

Effect of color and texture

The possible effect of the color and texture of the meat samples on identification can be seen by comparing the results of Experiments 1 and 2 in Tables 1 and 2. From Table 1 it can be seen that the percentage of correct identifications for lamb and veal on whole lean roasts is approximately the same as for ground lean roast, but the number of correct identifications of beef and pork decline for ground meat. However, according to Table 2, only the difference in the beef samples was statistically significant. Thus the texture of the whole lean beef roast, and possibly the color of the whole pork roast were sufficiently characteristic to aid in the identification of these meats.

Table 3. Identification of four identical samples of veal by 25 panelists.

Identification	%
Beef	32
Veal	33
Pork	24
Lamb	11

Correct identification

The percentage of the total number of correct identifications made in each experiment, and also the percentage of the panelists in each experiment that were able to identify correctly each meat sample and all four samples are shown in Table 1. The data based on all the identifications made indicate that, where the panelists depended on their memory of the characteristic flavor of the meat, the best they could do was to identify 63% correctly (Experiment 3). In Experiment 4, where the panelists had known meat samples as a basis of comparison, they identified 80% correctly.

The proportion of panelists correctly identifying all four meats by memory alone was 37% or less (column 10, Table 1); about two-thirds of the panel were able to do so when comparing the unknowns with known meat samples.

Although these data indicate that the ability of the panel to identify the meats by memory is not very high, statistical analysis of the correct identifications of the meats by variety shows no significant difference between memory identification and direct comparison with a standard. For this analysis the normal, ground meats of Experiment 3, identified from memory, were compared with the normal ground meats of Experiment 4, identified by direct comparison. The percent values (columns 6–9, Table1) show that all meats except lamb were identified less frequently by memory only, but the difference in the frequency of correct responses between Experiments 3 and 4 were not significant.

Effect of fat on meat flavor

It is popularly assumed that fat increases the flavor of meat. However, few organoleptic studies have been carried out to determine the role of fat in the formation of the characteristic flavor of the meats. A comparison of the results of Experiment 3, the normal ground meat, with Experiment 2, the lean ground meat, indicates that the absence of fat led to a significant decrease in the number of correct identifications of beef and lamb. The identification of veal and pork was not influenced by the absence or presence of fat.

Hornstein *et al.* (1960) stated that lean meats of the various species have essentially the same basic aroma and that the species-specific aroma is due to the fat. If the flavor precursors in the fat form the characteristic aroma on heating, the identity of the lean meat may not be important.

Table 4. Effect of adding unextracted or extracted beef, pork or lamb fat to veal on identification compared with that of veal alone or authentic meat.

	Comparison with			
	Veal[1]		Authentic meat[2]	
Added fat	Unextracted fat	Extracted fat	Unextracted fat	Extracted fat
Beef	No. sig. difference	No. sig. difference	Sig. lower	Sig. lower
Pork	Sig. higher	No. sig. difference	No. sig. difference	Sig. lower
Lamb	Sig. higher	Sig. higher	Sig. lower	No. sig. difference

[1] Comparison of identification of veal and added fat with random identification of veal as the particular meat (Expt. 5).
[2] Comparison of identification of veal and added fat with identification of natural ground roast (Expt. 3).

On the other hand, if lean meat is the major contributor to the characteristic flavor note, then, fat, regardless of species, could play a minor role.

To explore this further, veal was selected as the basic lean meat to which fats of other species were added. The choice of veal was made on the basis of the natural leanness of the meat and its normally bland flavor. In Experiment 5, four samples of veal were given to each of 25 panelists. The identifications are shown in Table 3. Of the 100 samples of roasted ground veal presented, about one-third were identified as beef and one-third as veal; pork was the choice of 24% of the panel and lamb, 11%. Beef, pork or lamb fat, in portions equal to 10% of the weight of the veal, were ground with veal and roasted. Identification was considered correct when the panelist recognized the veal plus fat as the species of meat corresponding to the fat. A scoring of "veal" for a sample of veal plus fat was considered incorrect. Experiment 6 in Table 1 shows the results obtained. The Chi-square test was used to analyze the difference between the responses to veal alone as a specific species of meat (Experiment 5) and the responses to the veal plus fat as the same species. The addition of beef fat did not significantly increase the number of identifications of veal as beef. Addition of pork fat resulted in a number of correct identifications of veal as pork that was significant ($P < 0.05$), while the identification of veal + lamb fat as lamb was highly significant ($P < 0.01$).

The responses in the identifications of veal + fats (Experiment 6) also were compared with those of natural ground roast (Experiment 3) as shown in Table 2 to determine whether the rate of identifications was the same. The identification of both "beef" and "lamb" was significantly less when the fats were added to the veal, but the addition of pork fat to veal resulted in a rate of identification that was not significantly different from that of the natural meat.

Fat was extracted from fatty tissue and added to the veal under the same conditions as the previous experiment. The results are shown as Experiment 7 in Table 1. A comparison of the results of the unextracted fat and the extracted fat experiments (Experiment 6 vs Experiment 7) indicated no effect of fat extraction on the identification of veal as beef, but the identification of pork was less frequent while the number of correct identifications of lamb increased. Chi-square analysis of the differences between the frequency of responses in these tests indicates that now beef and pork were not identified to a significantly different extent than veal was when presented alone (Experiment 5).

Lamb identification, however, increased significantly. From Experiments 3 and 7 it can be seen that veal with the addition of extracted beef or pork fat was identified significantly less often than natural beef or pork, but veal with lamb fat was identified as lamb approximately as often as natural lamb. These results are summarized in Table 4.

DISCUSSION

THE CORRECT IDENTIFICATION of meat by memory of flavor alone is not as readily accomplished as it appears to the average person. Before beginning the tests, most of the panel felt they could identify the various species of meat; however, only about one-third of the group was able to identify all four meats correctly. The effect of texture and color of the meat, as well as the method of preparation—the seasoning, spicing and garnishing—influences the psychological processes leading to recognition. When identified standards were supplied for comparison, the number of correct identifications of the meats increased but were not statistically significant; about a third of the panel still was unable to identify all four of the meats.

While the ability of either men or women to identify the meats correctly was not considered an inheritable, sex-linked characteristic, it was thought that women, by virtue of their experience and training in food preparation, might score better than men in this type of test. The results, however, indicate no statistically significant difference between the sexes. Minnich *et al.* (1966) however, reported that men consistently displayed greater taste sensitivity than women in the identification of chicken flavor in broth.

The effect of texture, color and other extraneous factors must be eliminated from tests of this type. Our results confirm the findings of Howe *et al.* (1937) that beef and pork were identified correctly more often than lamb or veal. These authors attributed the differences to the effect of fat whereas our data, using crumbled ground meat, implicated selection based on the color and texture of the meat. Fat, however, may play a role in the identification of meat; beef and lamb were identified significantly more often in fat-containing ground roasts than in lean ground roasts, whereas the identification of veal and pork were unaffected by the presence of the fats.

Another type of experiment in which specific fats were added to lean meat was carried out to determine the role of the fat in characterizing the meat species. There are three possibilities for the development of flavor involving fat: (1) the fat contains precursors that liberate the species-specific aroma on heating, and the lean meat itself has little or no effect; (2) there is an interaction between lean meat and fat components to give the desired aroma, and the lean meat components may be either specific or non-specific for the species; (3) fat does not contain compounds that yield species-specific aroma.

Veal was selected as the basic lean meat because it has less fat and its flavor is blander and less distinctive than the other meats. The flavor of veal resembles that of beef resulting in confusion between the two, and this was demonstrated when about a third of the panel identified veal as beef and another third correctly called it veal.

It was surprising to find 25% of the panel identifying veal as pork. Beef fat added to veal did not make veal resemble the normal beef roast and the identification of veal plus beef fat as "beef" was about the same as the random identification of veal alone as "beef." Pork fat, however, contained a factor that increased recognition of veal as pork to a point where it was significantly like that of normal pork. Extracting the fat with fat-solvents and washing with water removed this factor and then pork fat did not affect the identification of veal. The results with lamb fat are of interest. The addition of lamb fat significantly increased recognition of veal as lamb, but not to the extent to which normal lamb was identified. Extracting the fat resulted in the concentration of the flavor factors

so the veal was identified as lamb as often as regular lamb.

Hofstrand *et al.* (1960) studied the effect of fat on the flavor of lamb and mutton. Depot fats were found to have flavor components that were changed by heat; however, heating the fats gave aromas that were not particularly lamb-like according to the judges. Furthermore, the aroma fraction was water-soluble, whereas the factor in the study reported here was concentrated in or with the fat.

The high rate of lamb identification was surprising because most of the panelists had indicated that they had eaten very little lamb previously or that they did not care for lamb. The flavor of lamb is evidently so characteristic it can be identified by people with little previous exposure.

On the basis of these experiments the role of fat in giving character to the flavor of a meat is not the same in every case. Beef fat appeared to have little or no effect on the development of a characteristic beef aroma. Pork and lamb fats apparently contain some factor(s) that develop a specific aroma on heating with veal. The pork fat factor, however, is water-soluble, while the lamb fat factor is either a component of the fat or is fat-soluble.

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